

A Nanoscience Research Center In the Northeast United States

A rendering of the
Center for Functional
Nanomaterials to be
built at Brookhaven
National Laboratory



What is the Center for Functional Nanomaterials?

The Center for Functional Nanomaterials (CFN) at Brookhaven Lab will provide scientists with state-of-the-art capabilities to tailor materials at the atomic level, with the aim of understanding how to improve materials' chemical or physical functioning. The "functional nanomaterials" resulting from this understanding are expected to have broad applications as the basis of future technology, such as faster computers, improved solar energy conversion, and more efficient catalysis of chemical reactions.

Why establish this facility at Brookhaven?

Brookhaven National Laboratory is an ideal location to establish one of the five Nanoscale Science Research Centers being built by the Office of Science of the U.S. Department of Energy at its national labs, as its researchers have a long history of achievement in developing an understanding of the structure and function of materials down to the nanoscale. Once the center is built, the Laboratory will then be able to expand its nanoscience collaborations involving faculty at universities across the country, many of whom are performing complementary studies.

Among the many tools that Brookhaven employs in performing nanoscience, the following three Laboratory facilities will complement the new center:

- **NATIONAL SYNCHROTRON LIGHT SOURCE:** where intense light reveals the structure and function of a range of materials and specimens.
- **LASER ELECTRON ACCELERATOR FACILITY:** where molecular charge transport is studied during certain chemical reactions.
- **TRANSMISSION ELECTRON MICROSCOPE:** where the electronic, magnetic, and optical properties of materials are examined at the atomic level.



National Synchrotron
Light Source at Brookhaven

A View of Brookhaven

Funded by the U.S. Department of Energy, Brookhaven National Laboratory is a multipurpose research institution located on a 5,300-acre site on Long Island, New York. The Laboratory operates large-scale scientific facilities and performs research in physics, chemistry, biology, medicine, applied science, and advanced technology.

In addition to Brookhaven's 3,000 scientists, engineers, and support staff, some 4,000 researchers from across the country and around the world come to the Laboratory each year to use its research facilities and collaborate with its scientific staff.



An aerial view of Brookhaven National Laboratory.



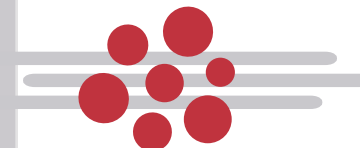
P.O. Box 5000
Upton, NY 11973-5000

www.bnl.gov
(631) 344-2345
pubaf@bnl.gov

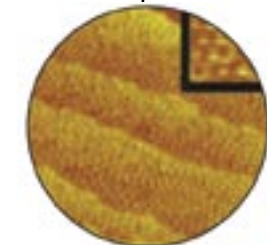
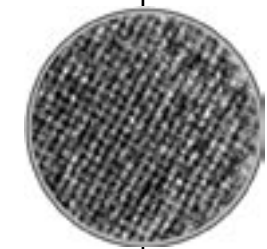
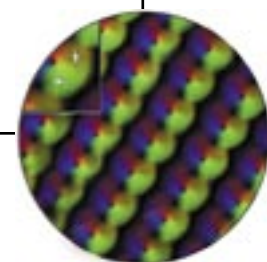
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Nanoscience: Manipulating Materials At the Atomic Level

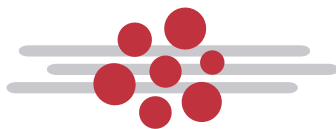
What is nanoscience?

Nanoscience is the study of materials at ultra-small dimensions — on the scale of a nanometer, which is a billionth of a meter (0.000000001 meter). For example, today's smallest electronic component in an integrated circuit is 250 nanometers per side. Proteins, the molecules that catalyze chemical reactions in cells, are 1 to 20 nanometers in size. In contrast, the diameter of a human hair is approximately 10,000 nanometers.

Nanoscale science, engineering, and technology is an emerging, interdisciplinary area involving materials scientists, chemists, physicists, biologists, and other researchers. Their goal: to work atom by atom, molecule by molecule to design and assemble new materials that have desired properties and functions. Once developed, these nanomaterials will be the basis of the products and processes of tomorrow.

What are the possible benefits of nanoscience?

- New energy conversion technologies (solar, hydrogen, etc.)
- Stronger and lighter materials for safer and more efficient transportation technologies
- Novel chemical and biological sensing for environmental and medical applications
- Improved catalysts for more efficient and cleaner manufacturing processes
- More efficient catalysts for remediation of pollutants and pathogens in the environment



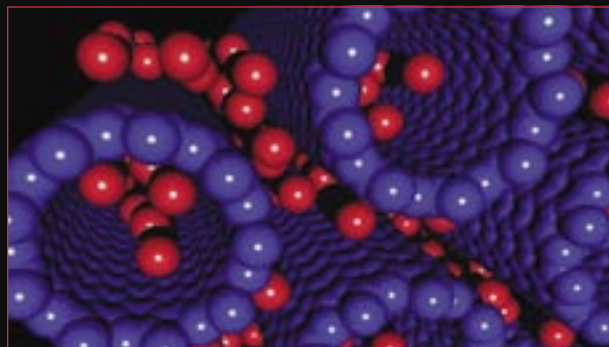
Center for Functional Nanomaterials
Brookhaven National Laboratory

Main Nanoscience Project Areas at Brookhaven National Laboratory

Research at the Center for Functional Nanomaterials (CFN) will focus on three areas —

Magnetic Nanomaterials

Nanostructured magnetic materials exist in a wide assortment of devices, including computers, cars, appliances, sensors, and medical equipment. Incorporation of advanced magnetic materials into devices will result in very significant savings of both money and greenhouse gas production.



Schematic illustration of hydrogen atoms (red) penetrating single-walled carbon nanotubes

The Hydrogen Economy

Hydrogen used as a major fuel is a potential long-term energy approach for the United States. Nanomaterials can empower the transition to hydrogen in the next 50 years, significantly changing the energy economy by reducing air emissions and expanding domestic energy resources.



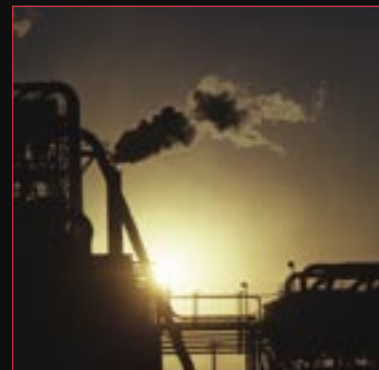
Ru nanoparticle catalysts



Magnetic and structural images of $\text{Nd}_2\text{Fe}_{14}\text{B}$ supermagnets

Catalysis

A catalyst is the chemical or biological agent that enables a chemical reaction to occur. Catalysis is key to energy conversion and environmental protection in chemical manufacturing and transportation, and nanostructured materials provide extraordinary opportunities to dramatically improve catalytic performance.



Catalysts provide energy-efficient pathways for important industrial processes, fostering cleaner, more efficient chemical plants.